भारतीय मानक
Indian Standard

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भूकृत्रिम — तटीय और जलमार्ग संरक्षण के लिए सुई छिद्रित बिना बुने हुए जियोबैग — विशिष्टि

Geosynthetics — Needle Punched Nonwoven Geobags for Coastal and Waterways Protection — Specification

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भारतीय मानक ब्यूरो
BUREAU OF INDIAN STANDARDS
मानक भवन, 9 बहादुरशाह ज़फर मार्ग, नई दिल्ली–110002
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI-110002
www.bis.org.in www.standardsbis.in

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Geosynthetics Sectional Committee, TXD 30

FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Geosynthetics Sectional Committee had been approved by the Textile Division Council.

Geobags find wide usage in riverbank, beach protection and offshore breakwaters for costal and waterways protection. Geobags, a geosynthetic product made of polyester or polypropylene has been used worldwide for protecting riverbanks and hydraulic structures from severe scouring and erosion. Geobags have also been used as revetments, breakwaters, etc, to build structural erosion protection measures. Such bags provide stability and prevent soil/coastal erosion. Geobag technology possesses minimal impacts on fish resources and facilitates fishing activities. It facilitates the algal community to grow. The technology has been popular worldwide due to its easier installation, cost effectiveness, their technical efficiency and environmental friendliness in comparison to the conventional erosion protection work using cement concrete block, gravel, hard rock, etc.

Worldwide it has been seen that erosion protection work using geobags requires less installation and maintenance cost, light weight equipment, less space for construction work, much less transportation cost and less energy requirement. The constructing materials (sand) of geobag are locally available and cost-effective compared to importing boulders from other sites. The geobags are lighter in weight than the traditional materials and their manufacturing and quality control are easy as compared to the cement concrete blocks and boulders. Geobags are filled with sand/dredged material and are generally used when sea shores or bunds adjacent to rivers are to be protected in case of an emergency.

For best performance, geobags have to be filled to maximum volume and density with sand. These are installed in a pattern-placed arrangement that greatly improves their overall stability and performance. Filling task can be efficiently done by using water to compact the sand (hydraulically filling the sand into a bag). Filled density and volume are important from the view point of maximizing the stability, but it is also important from the view point of minimizing the effects of fill liquefaction and loss of shape of the geobags. To ensure that the contained fill is maintained in its dense state, the geo-textile fabric shall have adequate tensile strength.

One major advantage of geobags is that these small volume units can be used to construct hydraulic and marine structures that require adherence to designed geometrical shape accurately. This makes them preferable to large volume units such as geocontainers when specific slope and height tolerances are to be attained. Another advantage of small volume units of geobags is that maintenance and remedial works can be carried out easily by replacing the failed bags. This is much simpler than carrying out remedial works on larger volume containment units.

Geobags can be used for a range of hydraulic and marine applications as given below:

a) *Revetments* — Geobags are used for revetments where their contained fill is used to provide stability and prevent erosion. Like geotubes, geobags have been used for both submerged and exposed revetments. Much of the details concerning geotube revetments also apply to the geobag revetments. To prevent erosion of the foundation soil at the toe of the revetment, it is common practice to extend the bottom layer of the geobags so that the main revetment cannot be undermined.
b) *Groynes* — Geobags can be used to construct groynes to prevent the shoreline movement of sediments.
c) *Artificial reefs* — Geobags can be used to construct artificial reefs. A major advantage of geobags is that, they can be installed to better geometric tolerances than relatively large volume geocontainers. Also being smaller in volume and having considerably better fill density, make the geobags less prone to volume changes than the relatively large volume geocontainers. Artificial reefs are normally required to dissipate wave energy and thus prevent erosion of the protected shoreline. Here the reef shall have desired height and area, with the geobags providing a mass gravity structure. Further as with geocontainers, geobags can be used for slope buttressing and for construction of protection dykes.

Geobags are readily available and transportable (when empty) and can be easily filled with local sand and formed

(*Continued on third cover*)

Indian Standard

GEOSYNTHETICS — NEEDLE PUNCHED NONWOVEN GEOBAGS FOR COASTAL AND WATERWAYS PROTECTION — SPECIFICATION

1 SCOPE

1.1 This standard specifies requirements for three types of geobags made from needle punched non-woven fabric of polyester (PES) or polypropylene (PP), used for coastal and waterways protection applications such as revetments; river training; construction of groynes and artificial reefs; etc, in order to minimize soil erosion and control floods.

NOTES

1 The survivability/durability of geobag depends upon water pressure, soil condition, type of contents of geobag that is sand or gravels, water *p*H and temperature etc.

2 Woven slit film geotextiles, that is, geotextiles made from yarns of a flat, tape-like character, shall not be used for the manufacture of geobags for permanent erosion control applications

1.2 This standard does not apply to other types of geosynthetic erosion control materials such as turf reinforcement mats.

2 REFERENCES

The standards listed in Annex A contain provisions which through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 DEFINITIONS

The definitions given in IS 13321 (Parts 1) and the following shall apply.

3.1 Minimum Average Bag Value (MABV) – MABV is the minimum average value of geobags minus two standard deviations.

4 REQUIREMENTS

4.1 Material of Geobags

4.1.1 Geobags shall be made from needle punched nonwoven fabric (Types 1 to 3) manufactured from ultra violet stabilized polyester or polypropylene and constituent fibre shall be identified by the microscopic and confirmatory tests as specified in IS 667; depending upon the end use requirements and shall conform to the requirements as specified in Table 1. The geobags shall be inert to commonly encountered chemicals, resistant to rot and mildew and shall have no tear or defects which adversely affect or alter its physical properties.

4.1.2 All property values except apparent opening size in these specifications represent minimum average bag values (MABV). Average of test results from any sampled bag in a lot shall meet or exceed the minimum values specified in this standard. In case of apparent opening size, the MABV shall represent the maximum average bag value.

4.1.3 Polymers used in the manufacture of geobags, shall consist of long chain synthetic polymers, composed of at least 95 percent by weight of virgin polypropylene or polyester. In any case recycled polyester shall not be permitted in view of its inherent non-uniformity and substandard quality as compared to virgin polyester fibre. The isophthalic acid content of the virgin polyester fiber shall be zero when tested by the method prescribed in Annex C. Polypropylene fiber generally used is virgin only as it is not recycled.

4.2 Geobags shall be dimensionally stable and able to retain their geometry under manufacture, transport and installation.

4.3 Prefabrication of Geobags

Geobags shall be prefabricated using UV stabilized polyester/polypropylene thread. The geobags shall have seam with double line chain stitches along the edges on two sides with a stitch density of 20 ± 2 stitches/dm. Number of stitches shall be chosen in such a way that seam strength is achieved at least 80 percent of fabric strength. If seam is intact then the strength of fabric broken shall be at least 80 percent of its original strength. The sewing shall be done at a minimum distance of 10 mm from edges by using a ring spun polyester/polypropylene thread, as the case may be, of linear density 1 500 - 2 500 Denier (167 – 278 Tex) for bags up to 400 g/m^2 and of 2 500 - 3 500 Denier (278 - 389 Tex) for bags greater than 400 g/m^2. The distance between the two rows of stitches shall be 5 to 10 mm. Stitch lines on both sides of the bags shall continue beyond the bag's open mouth and end in a loose loop of thread of length 25 to 50 mm. The stitching shall be uniform without any loose thread or knot.

5 MARKING AND LABELLING

5.1 The geobags shall be marked with the following by attaching the printed labels:

Table 1 Requirements of Needle Punched Nonwoven Geobags for Coastal / Waterways Protection

(*Clause* 4.1.1)

Sl No.	**Characteristics(s)**	**Requirement(s)**			**Method of Test, Ref to**
		Type 1	Type 2	Type 3	
(1)	(2)	(3)	(4)	(5)	(6)
A.	**Mechanical Properties:**				
i)	Wide with tensile strength, KN/m, *Min*:				IS 13162 (Part 5)
	a) Machine direction	15	20	24	
	b) Cross machine direction	15	20	24	
ii)	Elongation, percent, *Min*:				IS 13162 (Part 5)
	a) Machine direction	50	50	50	
	b) Cross machine direction	50	50	50	
iii)	Seam strength, Percent of actual fabric strength, *Min*	80	80	80	IS 15060
iv)	Abrasion resistance, Retained tensile strength in machine and cross machine direction, *Min* (*see* Note 1)	95	95	95	IS 14714
	OR				
	Abrasion resistance, Retained tensile strength in machine and cross machine direction, *Min* (*see* Note 1)	80	80	80	Annex B
v)	Trapezoidal tear strength, N, *Min*:				IS 14293
	a) Machine direction	340	450	600	
	b) Cross machine direction	340	450	600	
vi)	CBR puncture resistance, N, *Min*	3000	4000	4700	IS 16078
B.	**Hydraulic Properties:**				
i)	Permittivity, s^{-1}, *Min*	1.25	1.10	1.00	IS 14324
ii)	Water permeability at 100 mm water head, 1/m^2/see, *Min*	60	40	30	IS 14324
iii)	Apparent opening size (AOS), micrometer, *Max*	75	75	75	IS 14294
C.	**Physical Properties:**				
i)	Thickness at 2 kPa, mm, *Min*	3.0	3.0	4.0	IS 13162 (Part 3)
ii)	Polymer Type; Polyester (PES) or Polypropylene (PP)	PES/PP	PES/PP	PES/PP	IS 667
iii)	Mass, g/m^2, *Min*	300	400	600	IS 14716
iv)	Length of geobag, m, *Min*:				IS 1954
	a) Small Size	1.00	1.00	1.00	
	b) Large Size	2.00	2.00	2.00	
v)	Width of geobag (Stich to stich), m, *Min*:				IS 1954
	a) Small size bag	0.70	0.70	0.70	
	b) Large size bag	1.50	1.50	1.50	
vi)	Mass of sand filled geobag, kg, *Min*:				Electronic weighing balance
	a) Small size bag	126	126	126	
	b) Large size bag	1 350	1 350	1 350	
vii)	Durability (*see* Note 2)	Shall be durable for a minimum of 5 years in natural soil with 4 ≤ *p*H ≤ 9 and soil temperature between –20°C to 25°C.			
viii)	UV resistance after 500 h, Retained tensile strength in machine and cross machine direction, percent, *Min*	80	80	80	IS 13162 (Part 2)

NOTES

1 As per agreement between the buyer and the seller, abrasion resistance test is to be carried out either by test method specified in IS 14714 or as per Annex B.

2 Manufacturer shall provide certificate for estimated durability of geobags.

a) Identification of the geo-textile material as per manufacturer's recommendation, for example, polypropylene nonwoven geobags for coastal/ waterways protection;
b) Type of geobag/mass, in g/m^2, of fabric used for manufacture of geobag;
c) Dimensions (length and width) of bag;
d) Lot number and date of manufacture;
d) Manufacturer's name, initials or trade-mark;
e) The Country of origin; and
f) Any other information/instruction provided by the manufacturer/required under law.

5.2 BIS Certification Marking

The geobags may also be marked with the Standard Mark.

5.2.1 The use of the Standard Mark is governed by the provisions of the *Bureau of Indian Standards Act*, 1986 and Rules and Regulations made thereunder. The details of conditions under which the license for the use of the Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

6 PACKING

Each bundle shall be labelled or tagged to provide product identification sufficient for field identification as well as inventory and quality control purpose. Bundles shall be stored in a manner which protects them from adverse impact of weather. If stored outdoors, they shall be elevated and protected with a waterproof cover. 50 geobags are laid flat in a HDPE tube or wrapped in a HDPE film of minimum thickness of 60 microns and tied with a HDPE/PP tape so as to remove excess air and to prevent it from the adverse impact of heat and moisture, oil, grease, dirt, dust and other stains as well as to extended ultra-violet exposure during shipment and storage prior to deployment and placement.

7 STORAGE AND HANDLING

7.1 During storage, geobags shall be elevated off the ground and adequately protected from the following:

a) Site construction damage;
b) Excessive precipitation;
c) Extended exposure to sunlight;
d) Aggressive chemicals;
e) Flames or temperatures in excess of 60°C;
f) Excessive mud, wet concrete, epoxy, or other deleterious materials coming in contact with and affixing to the geo-textile material;
g) Any other environmental condition that may damage the physical property values.

7.2 The geobags shall be stored at temperatures above 10°C and below 40°C

7.3 The geobags shall be laid flat.

7.4 The geobags shall not be directly exposed to sunlight for a period longer than the period recommended by the manufacturer.

7.5 The geobags shall be kept dry until installation, and shall not be stored directly on the ground.

8 SAMPLING AND CRITERIA FOR CONFORMITY

8.1 Lot

The number of geobags of the same size, type and quality delivered to a buyer against one dispatch note shall constitute a lot.

8.2 The number of geobags to be selected at random shall be according to col 2 and col 3 of Table 2. To ensure the randomness of selection, IS 4905 may be followed.

8.3 NUMBER OF TESTS AND CRITERIA FOR CONFORMITY

8.3.1 The number of geobags to be selected for length, width, mass, thickness, mass of sand to be filled and pre-fabrication requirements shall be in accordance with col 3 of Table 2. For wide width tensile strength, elongation, seam strength and trapezoidal tear strength, the number of geobags selected shall be in accordance with col 5 of Table 2. For all other tests, the number of geobags selected shall be as given in col 6 of Table 2.

NOTE — If agreed to between the buyer and the seller, the sampling at the consumer/user end at site shall be carried out for deciding the conformity of the lot.

Table 2 Sample Size

(*Clauses* 8.2, 8.3.1 *and* 8.3.2)

Sl No.	Lot Size (No. of bundles of 50 Geobags)	Sample Size (No. of Geobags)	Permissible Number of Non-conforming Bags	Sub-Sample Size (No. of Geobags)	Sub-Sub-Sample Size (No. of Geobags)
(1)	(2)	(3)	(4)	(5)	(6)
i)	Up to 100	5	0	2	1
ii)	101 to 200	8	1	4	2
iii)	201 to 300	13	1	5	3
iv)	301 to 500	20	2	8	4
v)	501 to 1000	32	3	10	5
vi)	1 001 and above	50	3	10	6

8.3.2 All the geobags selected from the lot shall be tested for various requirements as per methods specified in relevant standards as specified in Table 1 and **4.1.1**, **4.1.3**, **4.2** and **4.3**. A geobag shall be declared defective if it does not meet any of the requirements specified in Table 1 and in **4.1.1**, **4.1.3**, **4.2** and **4.3**. The lot shall be declared conforming to this standard, if the average of test results from sampled bags in a lot shall meet or exceed the minimum values specified in this standard against each requirement; except in case of apparent opening size where the average value of test results shall not be more than the value specified in Table 1. The lot shall also be declared conforming to this standard, if the number of defective geobags does not exceed the values specified in col 4 of Table 2. In addition to above the lot shall meet the requirements of marking and labelling (*see* **5.1**), packing (*see* **6**) and storage and handling (*see* **7.1** to **7.5**).

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
667 : 1981	Methods for identification of textile fibres (with supplement) (*first revision*)
1954 : 1990	Determination of length and width of woven fabrics — Methods (*second revision*)
4905 : 2015	Random sampling and randomization procedures (*first revision*)
13162	Geotextiles — Methods of test
(Part 2) : 1991	Determination of resistance to the exposure of ultraviolet light and water (Xenon-Arc type apparatus)
(Part 3) : 1992	Determination of thickness at specified pressures
(Part 5) : 1992	Determination of tensile properties using a wide width strip
13321 (Part 1) : 1992	Glossary of terms for geosynthetics: Part 1 Terms used in materials and properties
14293 : 1995	Geotextiles — Method of test for trapezoid tearing strength
14294 : 1995	Geotextiles — Method for determination of apparent opening size by dry sieving technique
14324 : 1995	Geotextiles — Methods of test for determination of water permeability-permittivity
14714 : 1999	Geotextiles — Determination of abrasion resistance
14716 : 1999	Geotextiles — Determination of mass per unit area
15060 : 2001	Geotextiles — Tensile test for joints/ seams by wide-width method
16078 : 2013	Geosynthetics — Static puncture test (CBR test)

ANNEX B

[*Table* 1, *Sl No.* (iv)]

ABRASION RESISTANCE TEST

B-1 PRINCIPLE

The test method simulates abrasion loads on geobags such as that caused by the movement of rocks in a revetment. A mixture of stone chippings and water passes over geobag samples installed in a rotating drum for 40 000 revolutions in an anti-clockwise direction and 40 000 revolutions in a clockwise direction. If the samples are not destroyed in the test their tensile strength, thickness and mass per unit area are subsequently determined. The changes in the test values during the test are used to assess the abrasion resistance.

B-2 SAMPLING, NUMBER OF SAMPLES AND CONDITIONING

Eight samples, each measuring 200 × 300 mm, are cut out of the laboratory sample (4 each in machine and cross machine direction). The samples are stored under water with a temperature of 20 ± 5°C for a minimum of 24 h prior to the test. The samples are fastened onto steel plates for the test and installed in the abrasion sections of the test apparatus. The upper surface of the geobag sample shall be exposed to the abrasion loads.

B-3 TEST APPARATUS

B-3.1 The test apparatus (*see* Fig. 1) comprises an octagonal steel drum with eight test sections driven by a horizontal shaft, an adjustable drive motor, an electronic control system and a test frame. The direction of rotation can be changed and the number of revolutions per minute and the total number of revolutions can be set as required.

B-3.2 The composition of the abrasive material shall be as follows:

a) 2 kg of 8/11 mm angular-grained high-quality basalt chippings,
b) 1 kg of 5/8 mm angular-grained high-quality basalt chippings,
c) 1 kg of 2/5 mm angular-grained high-quality basalt chippings, and
d) 8 l of water.

B-3.3 If a different test set-up is used, the dimensions, geometry and rotational speed of the test drum and the type and quantities of abrasive material used shall be the same as those used for the test with given apparatus.

B-3.4 Other particle sizes can be used for suitability tests, depending on the loads expected to occur on site.

B-5 PROCEDURE

B-5.1 The test comprises two abrasion phases of 40 000 revolutions each. Set the drum speed at 16 rpm and reverse the direction of rotation every 5 000 revolutions. Examine the samples visually after the first 40 000 revolutions. If the samples have not been destroyed renew the abrasion mixture and carry out the second phase.

B-5.2 If the samples have not been destroyed after 80 000 revolutions, take four samples from the centers of the abraded surfaces and test their tensile strength as per the method given in IS 13162 (Part 5). Before conducting the tensile strength test, prepare the samples by washing them thoroughly and air drying them.

B-6 CALCULATION

Determine the percent retention of tensile strength in machine direction (MD) and cross machine direction (CD) as follows:

$$\text{Percent retention of tensile strength} = \frac{b}{a} \times 100$$

where

a = tensile strength of the sample (MD or CD) before abrasion test, and
b = tensile strength of the sample (MD or CD) after abrasion test.

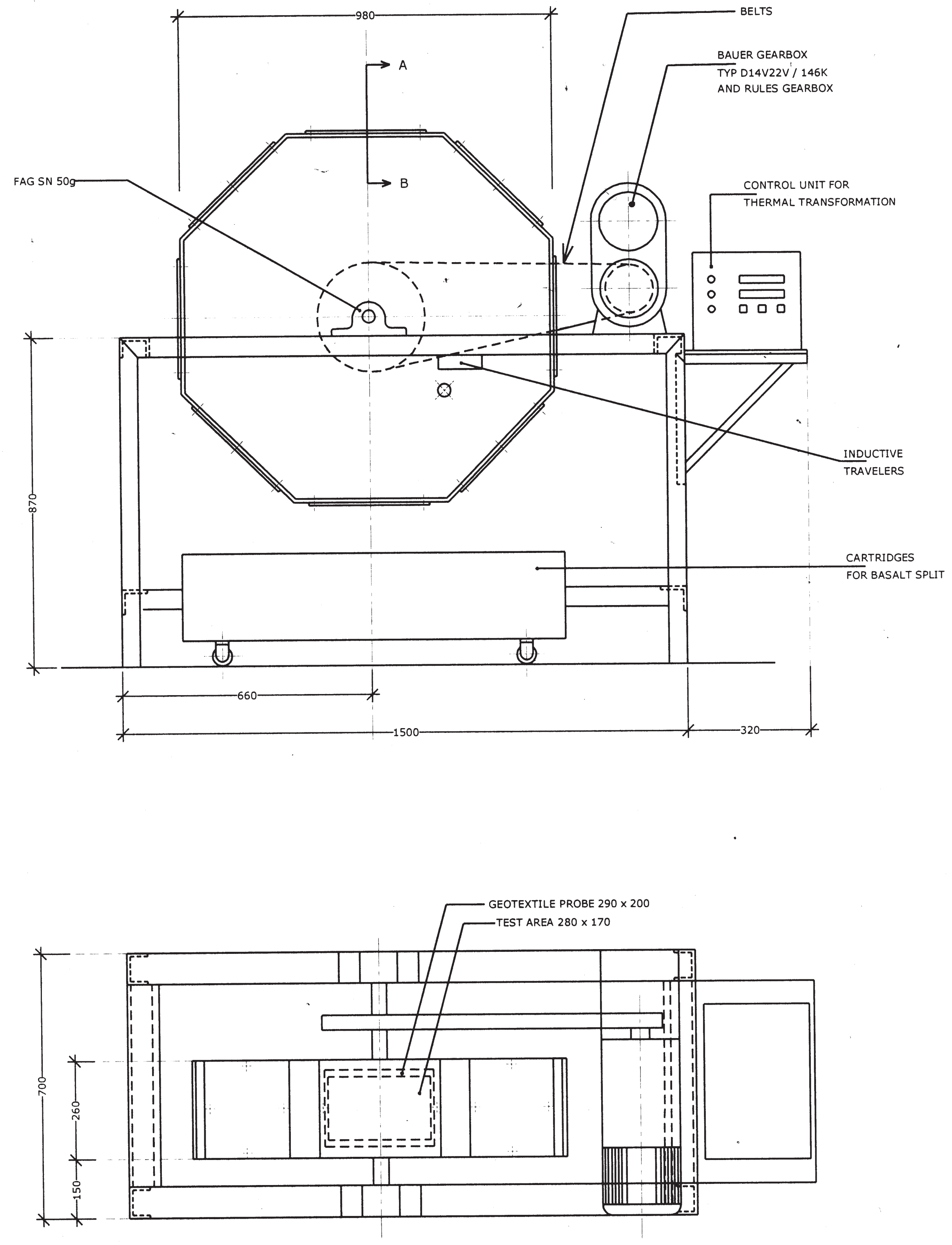

Fig. 1 Test Apparatus

ANNEX C

(*Clause* 4.1.3)

METHOD OF TEST FOR ISOPHTHALIC ACID CONTENT OF THE VIRGIN POLYESTER FIBRE

C-1 PRINCIPLE

This method is applicable to measure isophthalic acid content in polyethylene terephthalate sample. The polymer sample is digested in benzyl alcohol, depolymerized then esterified to dibenzyl isophthalate, dibenzyl terephthalate and glycol's. Isopropyl titanate is added as a depolymerization catalyst. The sample is analyzed by gas chromatography and the peak areas of the two esters are used to estimate the weight percentage dimethyl isophthalate using an internal standard.

C-2 POTENTIAL ENVIORNMENT ISSUE

C-2.1 In case of spillage, it can lead to pollution near the workplace area and environment hazard. After analysis sample is disposed as per laid down procedure.

C-2.2 Hydrogen, nitrogen and instrument air are used during analysis. The hydrogen gas has no adverse ecological effects are expected. Hydrogen does not contain any Class I or Class II ozone depleting chemicals. However, hydrogen is explosive. Gaseous nitrogen is an inert non-flammable gas. High concentration in air may cause deficiency of oxygen with the risk of unconsciousness and death. Chloroform in high concentration in air can kill most animals in few minutes.

C-3 POTENTIAL SAFETY, OCCUPATIONAL HEALTH ISSUES

C-3.1 Proper PPE's like safety goggles, apron, surgical hand gloves to be used.

C-3.2 Glassware is to be handled with care.

C-3.3 Leak check to be carried out while handling of gas cylinder.

C-3.4 Glassware is to be handled with care.

C-3.5 Inhalation of chloroform causes dilation pupils with reduced reaction to light as well as reduced intraocculat pressure, Irritation of mucous membrane, conjunctiva. If contacted with skin and eyes cause irritation. Seek medical advice, if inhaled.

C-3.6 Use leather hand gloves while handling hot apparatus and equipments.

C-4 APPARATUS

C-4.1 Gas Chromatograph (GC), with flame ionization detector.

C-4.2 Capillary Column, 60 m length and 0.53 mm ID MXT ® - 1

C-4.3 Dispensette or Pipette, 2 ml, 5 ml and 10 ml.

C-4.4 Volumetric Flask, 100 ml, 500 ml.

C-4.5 Beaker

C-4.6 Funnel

C-4.7 50 ml Flask

C-4.8 Heating Mental, to maintain temperature of 250°C.

C-4.9 AR Grade Dimethyl Isopthalate (DMI)

C-4.10 AR Grade Benzyl Alcohol

C-4.11 AR Grade Chloroform

C-4.12 AR Grade Isopropyl Titnate

C-4.13 AR Grade Dimethyl Suburate

C-5 PREPARATION OF STANDARD SOLUTIONS

C-5.1 Stock Dibenzyl Suburate (Internal Standard) Solution

Take 1.0 ± 0.01 g of dimethyl suburate (DMS). Add 100 ml of benzyl alcohol and 6 to 7 drops of isopropyl titnate and digest it for 2 h. Allow it to cool up to room temperature then make the volume to 500 ml by carefully rinsing the flask by isopropyl alcohol. Dimethyl suburate will get converted into dibenzyl suburate (DBS). Mark the stock solution as DBS per 2ml ≈ X·XXXX mg

C-5.2 Stock Dimethyl Isopthalate (DMI) Solution

Take 0.2 ± 0.01 g of dimethyl isopthalate (DMI). Add 40 ml of benzyl alcohol and 6 to 7 drops of isopropyl titnate digest it for 2 h. Allow it to cool up to room temperature then make the volume to 100 ml by carefully rinsing the flask by isopropyl alcohol. This will be converted to dibenzyl isopthalate (DBI). Mark the stock solution as DBI per 2 ml ≈ X·XXXX mg.

C-5.3 Standard Solution for Response Factor

Take 2 ml of solution as prepared in **C-5.1** and 2 ml of solution as prepared in **C-5.2**. Add 10 ml of chloroform.

C-5.4 2.0 Percent Standard IPA Stock Solution

Weigh out accurately 0.200 ± 0.005 g of pure DMI powder into round bottom flask, add 30 ml of benzyl alcohol and 3 drops of isopropyl titante, reflux the solution for 5 h reagent and dilute to 100 g by isopropyl alcohol, calculate actual DMI concentration by considering its purity and label the flask with actual weight taken. Consider this weight during calculation of IPA by GC.

C-5.5 2.0 Percent Standard IPA Solution for GC Injection

Take 2.0 ml IPA stock solution and add 2 ml internal standard (*see* **C-5.1**) and further add 10 ml of chloroform, same bottle to be labelled as 2.0 percent IPA Inject 1 µl in GC.

C-6 CALIBRATION FOR PERFORMANCE CHECK — TWICE /MONTH STANDARD CHIPS

C-7 ANALYTICAL PROCEDURE

Inject 1 µl of standard solution for response factor (*see* **C-5.3**) and calculate response factor. Inject 1 µl of 2 percent standard IPA solution. If value of 2.0 percent standard IPA solution is varying in the range of 0.01 percent, then there is no need for change in response factor. If there is deviation in value then rerun standard solution for response factor (*see* **C-5.3**). Weigh 0.2 ± 0.02 g of chips into the round bottom flask. Add 2 ml of benzyl alcohol. Add 3 drops of isopropyl titanate. Digest the solution for 1 h. Allow it to cool up to room temperature. Add 10 ml of chloroform. Add 2 ml of internal standard solution that is solution as prepared in **C-5.1** and shake vigorously. Inject 1 µl of sample solution into gas chromatograph.

C-8 CHROMATOGRAPH SETTINGS

Injector temperature	:	300°C
Detector temperature	:	320°C
Oven temperature	:	270°C

Gas flow rates

Nitrogen	:	20 psig
Hydrogen	:	30 ± 10 ml/min
Air	:	300 ± 20 ml/min
Attenuation	:	- 4
Range	:	1

C-9 CALCULATION

$$\text{Response factor (RF)} = \frac{A_1 \times W_2}{A_2 \times W_1}$$

where

A_1 = area of dibenzyl suburate (DBS) (Internal standard) solution;

W_1 = weight of DBS in solution, in mg;

A_2 = area of DBI in standard solution; and

W_2 = weight of DBI in standard solution, in mg.

$$\text{Percent IPA} = \frac{\text{RF} \times \text{mg Internal Standard} \times \text{Area of IPA in sample} \times 100}{\text{Weight of sample, in mg} \times \text{Area of internal standard in sample}}$$

ANNEX D

(*Foreword*)

GUIDELINES FOR USE OF POLYESTER/POLYPROPYLENE RAW MATERIALS AND TYPE OF GEOBAG FOR MANUFACTURE OF GEOBAGS

D-0 Polymeric materials like polypropylene and polyester are primarily used in the manufacture of geo-bags depending upon the end use properties required.

D-1 POLYPROPYLENE (PP)

Polypropylene is one of the raw materials used as fiber in geo-textiles and geo-bags. Polypropylene has advantage over other materials due to its lower density and higher chemical resistance to both acidic and alkaline environments. However, repetitive methyl groups attached along the backbone chain limit the chains' mobility, leading to different material behavior. Overall, the lower mobility of PP chains reduces internal chain reorganization. PP has poor creep resistance compared to polyester due to structure of molecules. The chemical resistance of polyesters is in the *p*H range of 3.0-9.0 which is normally the case of river waters where as chemical resistance of polypropylene is in the *p*H range of 2.0 to 13.0. PPs are not sensitive to environmental stress cracking, but are more sensitive to oxidation due to the presence of weaker carbon-hydrogen bonds on the tertiary carbon atom. Adequate stabilization against oxidation (thermo and photo oxidation) is, therefore, required. In short, Polypropylene has the following properties:

a) Polypropylene has excellent chemical resistance;
b) Polypropylene is very much resistant to microbiological attacks;
c) Polypropylene is not sensitive to environmental stress cracking;
d) Polypropylene has a lesser resistance to internal chain reorganization (creep, etc) than polyesters, especially at low temperatures; and
e) Polypropylene is very sensitive to oxidation and must also be stabilized with pigments, antioxidants and/or UV stabilizers to prevent degradation.

D-2 POLYESTER

D-2.1 Polyester (PET) is one of the main raw materials used in the manufacture of geobags, especially when high wettability is required (for example in geo-bags). PET fibres usually have a highly oriented semi-crystalline structure in order to reach the desired physical properties. Its chemical structure includes ester groups, which are the important polymeric links in terms of durability. PET fibres typically have an excellent chemical resistance to many products such as salts, organic solvents and hydrocarbons. However, under certain conditions (beyond *p*H of 11.0 or less than 3.0 which is not the case in river waters), they may be sensitive to chemicals such as inorganic acids, halogenated organic acids, inorganic and organic bases, benzyl alcohol and halogenated phenols. Its molecular structure is overall less sensitive to oxidation than PPs. Some chemical bonds of PET can be oxidized under the action of heat (thermo oxidation) or radiation (photo-oxidation). However, these reactions can be prevented with appropriate stabilizers. The glass transition of PET is in the range of 70°C. Chain movements at ambient temperature are thus very limited. This gives PET fibers an excellent resistance to creep and other process involving internal chain reorganization especially at wide range of temperatures.

D-2.2 In resume, the following durability concerns should be addressed for polyester geosynthetics:

a) Good chemical resistance to several classes of chemicals;
b) Hydrolysis potential (beyond *p*H range of 3.0-9.0) in alkaline or acid environments should be considered as polyester can be susceptible to damage in high *p*H applications;
c) Excellent resistance to internal chain reorganization (that is creep) at typical emperatures up to about 60°C;
d) Polyester can also be susceptible to heightened degradation where there is lime treated soil, concrete or cement present; and
e) Oxidation (especially thermo and photo oxidation) is also a concern, in lesser extent than PP, and requires material stabilization.

D-3 TYPE OF GEO-BAG

The survivability/durability of geo-bag depends on water pressure, soil condition, type of contents of geo-bag that is sand or gravels, water *p*H, and type of geobag that is woven, spun bonded nonwoven or needle punched nonwoven and is in the following descending order:

Woven geobag < Spun bonded Nonwoven geobag < Needle punched nonwoven geobag'

ANNEX E

(*Foreword*)

GUIDELINES FOR INSTALLATION OF GEOBAGS

E-1 PREAMBLE

E-1.1 Geobags are extensively used for river channel bed and bank protection, coastal/beach protection, scour protection of bridge piers, abutments, hydraulic structures, etc and construction of offshore breakwaters. It facilitates the algal community to grow. The proven advantages of geobags include easy and fast installation even underwater, less transportation cost, less maintenance, facilitation of growth of algal community, low environmental impact, less maintenance, less energy input, etc. Geobags offer proven, durable, economic, eco-friendly and easy to construct solutions for a wide range of applications.

E-1.2 Geobags are filled with sand/ dredged material and are used in planned structural erosion control and scour protection works. Geo-textile bags have also been used as revetments, breakwaters, etc to build structural erosion protection measures.

E-1.3 For ensuring required performance and service life of geobag works proper care has to be exercised in selection of the geotextile material, dimensions of the bags, fabrication of bags, selection of fill material as per design.

E-2 HANDLING AND STORAGE AT SITE

E-2.1 Geobags are packed in bundle form with suitable packing material and transported by appropriate means to protect the geobags and avoid any type of damage. Rolls of geobags are loaded manually/with Forklift and can be unloaded in a similar manner at the destination. Use of hooks shall be avoided for loading and unloading of the packages of geobags at site

E-2.2 The storage yard shall be located in a suitable-sized area depending on the quantity of materials required for the project. The layout of the storage yard shall be planned with due consideration to the movement of trucks and other heavy equipment that would be involved in the handling, that is loading and unloading.

E-2.3 Geo-textile bags shall be stored in such locations where water shall not accumulate and the area shall be immune from conditions that may affect the properties or performance of the product.

E-2.4 The geobags shall be stored so as to be protected from damage, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat or any other damage. The packages shall be stored on a prepared surface and to be stacked side by side or one upon the other.

E-2.5 Fire can inflict huge loss and damages to the materials stored in the yard. Therefore, adequate

numbers of fire extinguishers shall be available inside the warehouse

E-2.6 The storage area shall be protected from theft, vandalism and any other source which could create potential damage to the geobags.

E-2.7 Under no circumstances, the geobags shall be exposed to temperatures in excess of those recommended by the manufacturer or 60°C, whichever is less.

E-3 SITE PREPARATIONS

E-3.1 The site survey and bathymetric survey for the affected reach, where the geo-textile bag protection is proposed, shall be carried out.

E-3.2 The surface upon which the geobags are to be placed shall be adequately leveled and shall be free of protrusions that may cause snag and tear the fabric. Protrusions could be like ruts, erosion rills, depressions or debris, or any obstruction greater than 150 mm in height.

E-3.3 The surface which is to be protected by the geobags (stream bed/bank, shoreline, etc) shall be dressed/trimmed to the required grade/profile/slope as shown on the drawings or as directed by the engineer. Excavation may be mostly carried out by track mounted excavators. Lighter excavators may be employed, if required.

E-3.4 The excavated earth may be disposed of by tippers/tractors to a suitable distance from the bank sides, so as to reduce the overburden on the existing bank.

E-3.5 The loose earth residue remaining after the excavation by the machinery may be removed manually. The slope formation may be given necessary ramming to remove any undulations and corrected to the desired slope. At the bottom and top of the slope, anchor trench or key shall be prepared as per the required design.

E-4 COMMENCEMENT OF INSTALLATION OF GEOBAGS

E-4.1 The geo-textile bags shall be filled at a location which is preferably higher than the high flood level.

This would ensure that the filling process of the bag remains unaffected by the rain and subsequent changes in the water levels.

E-4.2 The sand used for filling may be transported to the site by dumpers and bulldozers or any other appropriate mode conducive to the local availability and geographical suitability.

E-5 GEO-TEXTILE BAGS FILLING AND LAYING OPERATIONS

E-5.1 The bags shall be filled with sand by suitable methods as approved by the engineer. It shall be ensured that the bags are not damaged or excessively distorted during filling.

E-5.2 The sand used for filling shall meet the gradation and other requirements as specified in the drawings or technical specifications of the project or as approved by the engineer.

E-5.3 After the sand filling is completed, the geo-textile bag shall be weighed to confirm the desired weight as per the specifications and technical requirements of the project.

E-5.4 After confirmation of the weight, the geo-textile bag shall be stitched at the mouth by means of a bag closing machine. Stitching shall continue beyond the bag's end in a loose loop of thread of length 25 to 50 mm.

E-5.5 After filling, for easy counting and monitoring the geo-textile bags may be stored in batches of 100 numbers or any suitable multiple as per the available space at site.

E-5.6 The placement of geo-textile bags for launching apron may be carried out using the motor boat/barge. The motor boat/barge may be positioned at the required location with the help of Total station and anchored in position with the help of anchors.

E-5.7 The placement of the geo-textile bags shall be continued up to the location of the key at the bottom of the slope near low water level.

E-6 POST INSTALLATION PRECAUTIONS

E-6.1 Immediately after installation, ensure the proper placement of geo-textile bags as per design and geometry of the site. If any abnormality observed, correction or re dumping shall be carried out.

E-6.2 Proper care shall taken to avoid manual interference of civilians and animals which can cause damage to the material.

The typical layout for installation of geobags is given below in Fig. 2.

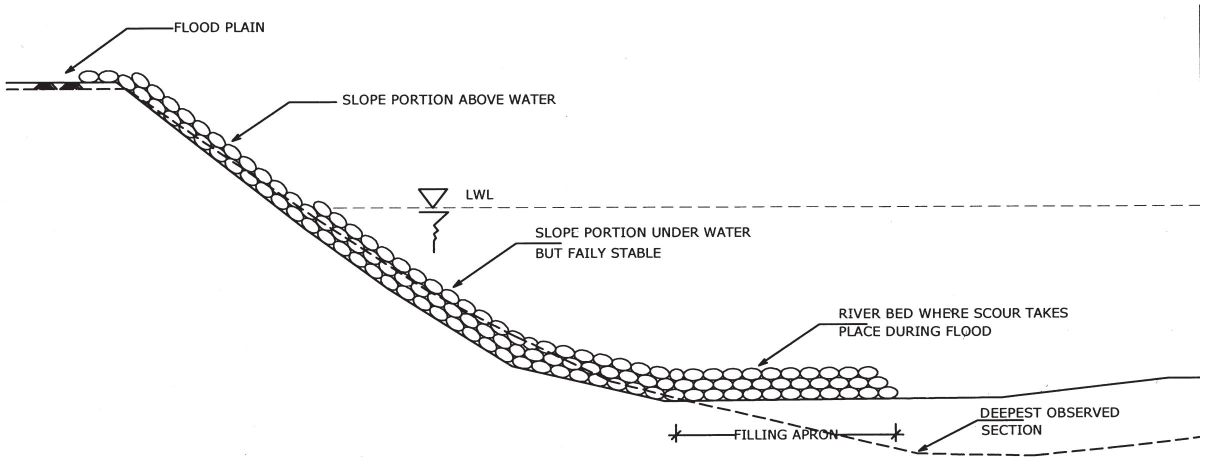
FLOOD PLAIN
SLOPE PORTION ABOVE WATER
LWL
SLOPE PORTION UNDER WATER BUT FAILY STABLE
RIVER BED WHERE SCOUR TAKES PLACE DURING FLOOD
DEEPEST OBSERVED SECTION
FILLING APRON

Fig. 2 Typical Layout for Installation of Geobags

ANNEX F

(Foreword)

COMMITTEE COMPOSITION

Geosynthetics Sectional Committee, TXD 30

Organization	*Representative(s)*
The South India Textile Research Association Council, Coimbatore	Dr A. N. Desai (***Chairman***)
Ahmedabad Textile Industry's Research Association, Ahmedabad	Dr Anil Kumar Sharma Shrimati Seema Patel (*Alternate*)
Brahmaputra Board, Guwahati	Shri Chaman Lal Shri Dhrubajyoti Borgohain (*Alternate*)
Central Coir Research Institute, Alappuzha	Dr D. Anita Ravindranath Shri R. Vasudev (*Alternate*)
Central Road Research Institute, New Delhi	Shri Sudhir Mathur Shri Jai Bahagwan (*Alternate*)
Central Soil and Materials Research Station, New Delhi	Dr R. Chitra Shri Manish Gupta (*Alternate*)
CIDCO, Mumbai	Representative
Department of Jute and Fibre Technology, Kolkatta	Dr Swapan Ghosh Prof (Dr) A. K. Samantha (*Alternate*)
Department of Water Resources, Assam	Representative
Directorate General of Supplies and Disposals, New Delhi	Additional Director General (QA)
DKTE Centre of Excellence in Nonwovens, Ichalkaranji	Shri Aniket S. Bhute
Flexituff International Limited, Mumbai	Shri Rajeeva Upadhyay Shri Nimesh Shukla (*Alternate*)
Ganga Flood Control Commission, Patna	Shri A. K. Sinha Shri Manoj Kumar (*Alternate*)
Garware Wall Ropes Ltd, Pune	Shri Tirumal Kulkarni Shri Rajendra Ghadge (*Alternate*)
Indian Jute Industries' Research Association, Kolkata	Dr. Mahuya Ghosh Shri Koushik Das (*Alternate*)
Indian Jute Mills Association, Kolkatta	Shri S. K. Chandra Shri J. K. Behera (*Alternate*)
Indian Technical Textile Association, Mumbai	Dr Anup Rakshit Shrimati Ruchita Gupta (*Alternate*)
Int Fab, Mumbai	Shrimati Aruna Lall
Kusumgar Corporates, Mumbai	Shri Y. K. Kusumgar Dr M. K. Talukdar (*Alternate*)
Macaferri Environmental Solutions Pvt Ltd, Navi Mumbai	Dr Ratnakar Mahajan
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National Institute of Research on Jute and Allied Fibre Technology, Kolkatta	Dr Gautam Bose Dr Sanjoy Debnath (*Alternate*)
Office of the Jute Commissioner, Kolkatta	Shri R. K. Roy Shri Soumyadipta Datta (*Alternate*)
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The Bombay Textile Research Association, Mumbai	Dr Anjan K. Mukhopadhyay Shri V. K. Patil (*Alternate*)
The Synthetics & Art Silk Mills Research Association, Mumbai	Dr Manisha Mathur Shrimati Ashwini Sudam (*Alternate*)
UP State Irrigation Department, Lucknow	Representative
Veermata JijabaiT echnological Institute, Mumbai	Dr Prashant Bhave
In personal capacity [*104, Kanchanban, A. W. Vartak Marg, Vile Parle (East), Mumbai 400 057*]	Shri V. N. Gore
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Member Secretary
Shri J. K. Gupta
Scientist 'D' (TXD), BIS

(*Continued from second cover*)

with range of sizes to fit specific application. On the other hand it has the demerit of high sensitivity to UV radiations and highly alkaline or acidic water. Depending on its constituent strains properties, its life expectancy could be reduced by 15 percent to 75 percent in one year of exposure. Ageing due to UV radiation could be avoided and protected using UV resistant polyester or polypropylene. Similarly highly acidic and alkaline water could also significantly reduce geobags property through chemical degradation. However, in river training water mostly the soil is in the *p*H range of 6.0 to 8.5 for which both polyester or polypropylene are always stable.

Survivability of geobags is very important from the viewpoint of their long term durability and is defined as resistance to mechanical damage during construction and initial operation. The ability of a geobag for permanent erosion control to survive installation and associated pressures during service shall be assured if it is to perform as designed. Selection of polymer and type of geobag is dependent upon survivability of geobags and information in this regard is given in Annex D for guidance only. Installation damage to a geobag is a function of the following:

a) Type of polymeric material that is polyester or polypropylene and whether UV resistant or not;
b) Geo-textile fabric thickness;
c) Compacting effort and fill thickness;
d) Grain size distribution of fill material; and
e) Angularity of fill material.

Guidelines for installation of geobags are given in Annex E for information only.

The composition of the Committee responsible for the formulation of this standard is given in Annex F.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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BUREAU OF INDIAN STANDARDS

Headquarters:

Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi 110002
Telephones : 2323 0131, 2323 3375, 2323 9402 *Website*: www.bis.org.in

Regional Offices:		*Telephones*
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Southern	C.I.T. Campus, IV Cross Road, CHENNAI 600113	2254 1216, 2254 1442 2254 2519, 2254 2315
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